**Introduction**

The growing awareness of the link between childhood diet and diseases in adulthood has led to increased interest in the dietary intakes of children and adolescents. Measurement of habitual food intake is one of the most challenging aspects of nutrition research. No dietary method can measure dietary intake without error. There is always some degree of misreporting. Assessing the dietary intakes of children and adolescents presents unique challenges.

As with adults, there is no perfect method of assessing dietary intake in children (McPherson 2000). Research to date suggests there are some considerable differences for this population. There is still much to be learned about the dietary intakes of children and adolescents. Only limited progress has been made in understanding the variables associated with misreporting in these age groups. We must be able to accurately assess the dietary intakes of our school-aged children so that we can monitor dietary intake trends, make accurate research and policy decisions, and develop and effectively evaluate nutrition interventions (McPherson 2000).

There is little research on the effect of age, gender, ethnicity, socioeconomic status and obesity and the affect of these factors on the validity of dietary assessment methods (McPherson 2000).

A greater understanding of the differences between the dietary intakes of healthy weight children and overweight/obese children is vital to the development of successful interventions for childhood obesity.
Issues to consider when assessing the dietary intakes of children and adolescents

These occur in spectrum from younger children to adolescents.

Cognitive Ability:
- Lower literacy skills
- Limited attention span
- Limited concept of time
- Limited memory – subconscious memory lapses across all or selected dietary items such as snacks
- Limited knowledge of food, food preparation & measurement
- Lack of familiarity with components of mixed dishes and added ingredients

Dietary Habits:
- Variable food habits - more structured in childhood than in adolescence
- More in-home eating (childhood)
- More out-of-home eating (adolescence)
- Parental influence important in childhood
- Peer influence important in adolescence

Other considerations:
- Body image concerns and dieting behaviours
- General lack of co-operation and motivation (adolescence)
- A conscious/subconscious need for social approval

It is uncertain how many of these factors affect reporting of dietary intake.
Parent reporting

Parents can be reliable reporters of their children’s intake in the home environment and parental report is vital in children < 8 years. However, parents are not reliable reporters of their child’s out-of-home food intake. This is a major limitation in studies using recall methodology in young children. Others who care for the child may need to be included in the reporting process. (Livingstone & Robson 2000) (Livingstone 2004).

Socioeconomic status of mothers is not related to the accuracy of dietary reporting for their children. (Livingstone & Robson 2000)

Despite the complexities of self-reporting, children & adolescents aged 9-16 have been shown to be reliable reporters of their food intake. By the age of 8-10 years children can reliably report their food intake, often as reliably as their parents. At a group level, repeated 24h recalls in this age-group may be a feasible alternative to a diet history interview with parents. (Livingstone & Robson 2000)

Portion size estimation

Few studies have attempted to assess the ability of children and adolescents to quantify portion sizes. The results of these studies have been inconclusive and contradictory (Livingstone & Robson 2000).

Children generally have difficulty in estimating portion size. A recent review was unable to make guidelines for portion size estimation for children or even adults. Training has been shown to improve portion size estimation among children, however, even with training some errors were reported to be as high as 100% (McPherson 2000).

Estimating the amount of food consumed is a complex task, even for adults. It requires that children can recognise and describe quantities in terms of proportions or whole units, that they have an adequately developed concept of time to express food intake in terms such as frequency and averages, and finally, it assumes that the child can think abstractly about food while viewing generic food models/photographs of different volumes and dimensions (Livingstone & Robson 2000).

To confound the problem is the food frequencies and portion sizes of children are not constant over time and it is also most unlikely they pay attention to frequencies and portion sizes they are eating (Livingstone & Robson 2000).
Given the substantial error documented in portion size estimation among adults, food intake for children should not place a high priority on portion size estimation (Cullen, Baranowski et al. 1998).

Overestimation of portion sizes tends to be greater in individuals who eat smaller portions and underestimation among those who eat larger portions (Biro 2002). Generally, overestimation of portion sizes appears to be more frequent than underestimation (Biro 2002, McPHerson 2000).

The assumption that including a quantification tool (photos, food models, household measures) to improve the accuracy of portion size estimation has not been verified. These tools can confuse children at best or exacerbate the problem at worst (Livingstone & Robson 2000).

There is little conclusive evidence of the greater benefit of any one type of portion size measurement aid (Biro 2002).
How children remember ..........& recall

There are limits to what children can remember, but little is known about the cognitive constraints on their ability to retain and retrieve dietary information (Livingstone & Robson 2000).

Dietary surveys based on recall rely ultimately on memory - which is subject to a variety of errors. The cognitive processes are complex - involve understanding what information is being asked for, and searching for and evaluating the retrieved information to provide an answer. Understanding how children retain, retrieve and recall dietary information is important for development of strategies that enhance recall (Livingstone & Robson 2000).

Limited research on children's recall of food intake shows considerable error can occur:

- Under-reporting (missing foods) - esp as the number of foods eaten in a meal increases or frequency increases, prevailing distractions, main course items easier to remember than secondary items, common foods are more easily recalled than less-common.
- Over-reporting (phantom foods)
- Incorrect identification of foods because of lower level of knowledge of foods and their preparation (Livingstone & Robson 2000)

Whether children younger than 10 years could give valid responses to a FFQ covering periods greater than 1d is much more debatable because of their inability to conceptualise frequency, averaging etc. (Livingstone & Robson 2000).

Influence of age on records and recalls:

Self-report is generally used with children older than 9 years. Children aged 10-12 are reliable respondents. Adolescents are capable but often less interested in participating than younger children. (Frank 1991)

Children younger than 9 years of age need adult assistance to provide accurate dietary information because they usually have limited reading skills and adults control most of the food offered, including the timing and frequency of eating occasions (McPherson 2000).

The number of days records or recalls required to assess a particular nutrient depends on the variability of the intake of that nutrient from day to day. The greater the variance of nutrient intake from day to day, the more days of recording required to rank subjects correctly. Children ≤4 years old adjust their EI at successive meals, so the within-subject daily EI is relatively constant. 7d of records are probably adequate
for ranking subjects for energy and most nutrient. Children and adolescents (5-17 years) have greater variance of intake, approximately twice that observed for adults, with females having consistently higher values. In dietary surveys that include both males and females, males will be ranked more accurately for most nutrients. The variability in intake is lowest for nutrients that are eaten regularly in the diet and highest for nutrients that are eaten in large amounts only occasionally eg. Carotene, retinol, vitamin B12, vitamin E. Vitamin intakes are most variable, often requiring $\geq 20$ d of records to capture habitual intake, particularly in girls. This makes records or recalls intrusive and burdensome in older children and adolescents. However, the application of FFQs or diet histories must be carefully evaluated, given the numerous problems in their application such as retrieval of dietary information from memory, conceptualization skills and portion size estimation (Livingstone & Robson 2000).

Adolescents self-reports are usually biased in the direction of under-reporting. Energy under-reporting increases with age during adolescence. Possibly because in younger children 7-10 year olds, the novelty and curiosity of recording food intake may help sustain enthusiasm to comply with the reporting process. In adolescence there is generally reduced interest in reporting food intakes and this is compounded by additional demands on recording due to increased energy requirements, unstructured eating patterns, a significant degree of out-of-home eating, dieting and weight consciousness, body shape and body image concerns (Livingstone & Robson 2000).

**Influence of obesity – child and parent**

**Child**

Obese children and adolescents under-report significantly more than their non-obese counterparts with the extent of mis-reporting increasing with age. Up to 40% EI in obese adolescents may go unrecorded, compared with 25% in 10 year olds and 14% in 6 year olds. Even in normal-weight adolescent populations, there is a positive association between underestimation of food intake and a tendency towards increased body fatness and overweight (Livingstone et al 2004). It is conceivable that obese teenagers may feel even more stigmatized about their fatness than obese adults. (Livingstone & Robson 2000). See also Rockett et al # 287 pg 35

There is some evidence that children with central fat distribution have higher rates of underreporting of energy intake than lean or obese children or those with peripheral fat distribution (McPHerson 2000). Another study reported energy intake was significantly lower in obese children than non-obese children when compared to doubly labeled water as a percentage of energy expenditure (McPherson 2000).
Underreporting of dietary intake by obese adolescents is consistent with recent findings that obese adults underreport their dietary intake. With the increasing prevalence of obesity among children and adolescents, it is essential to determine whether body size differences significantly affect completion of dietary assessment instruments (McPherson 2000).

One of the most robust findings in dietary studies of children and adolescents is the positive association between low-energy reporting and increased body fatness, particularly in adolescents (Livingstone et al 2004).

Obese adolescents underreport food intake significantly more than nonobese adolescents (Bandini 1990 #236).

Reporting error due to body weight status does not occur systematically across different age groups or different dietary survey techniques (Livingstone 2004).

Adolescents seem to underestimate energy intake by up to 50% individually (and obese subjects to a greater extent) (Biro 2002).

Parent

The influence of parental reports on children’s food intake is inconsistent. In lean children, parental obesity status has not been found to undermine the reported dietary intake. However, there is a bias towards underestimation in obese 6-7 year old children who have at least one obese parent (Livingstone & Robson 2000).

Klesges et al (1988 #14) found that in 36 children, the parents’ reports of dietary intake were the same regardless of their weight status.

Accuracy of reported energy intake

To date, the validation studies of EI reporting in children and adolescents have conclusively demonstrated the existence of misreporting, but unfortunately further progress in understanding the problem has been limited (Livingstone & Robson 2000).
The validation studies for each of the three main methods of dietary assessment suggest that the diet record and 24-hr recalls, and to a lesser extent the diet history, may provide more accurate group estimates of EI in younger age-groups. With increasing age, however, the reverse appears to occur with the diet history demonstrating better validity, at least at the group level. However, the small number of studies to date preclude any firm conclusion about the advocacy of one method over another (Livingstone & Robson 2000).

In children and adolescents, those who under-report on one occasion are likely to under-report on a second occasion, in which case the bias cannot be eliminated by repeated measures. Therefore, the assumption that repeated measures of dietary intake will eventually yield valid measures of habitual intake is not necessarily true.
Dietary Assessment Methods Comparison

Methods of dietary assessment

After 40 years of research, and a plethora of comparative studies, there are no universal criteria which can be applied when selecting data-collection methods suitable for studies of children and adolescents (Livingstone & Robson 2000).

There are too few validation studies in children to justify advocating one particular method over another. Dietary assessment techniques for children are difficult to evaluate and generalise because the validation standards against which the instruments have been compared are frequently beset with shortcomings. Differences in study design, referent periods and validation standards also makes it difficult to draw firm conclusions (McPherson 2000).

Dietary assessment methods for adults have been adapted for administration to a paediatric population. Specific adaptations include incorporating parental or adult assistance, adjusting portion size information, using shorter referent times and administering the instrument in the school setting (McPherson 2000).

The current body of literature recommends validation studies of all dietary assessment methods in children and adolescents to improve the dietary data obtained from children and adolescents.
Selecting a Dietary Assessment Method

The choice of dietary assessment method depends on;

- The objectives of the study
- The foods or nutrients of primary interest
- The need for group or individual data
- The need for absolute vs relative intake estimations
- Characteristics of the population
- Timeframe of interest
- Level of specificity needed for describing foods
- Available resources

Important preconditions are;
- skilled interviewers
- skilled data coders
- an accurate, preferably complete nutrient database (Biro 2002).
The relative merits of dietary assessment methods in children and adolescents

The primary dietary assessment methods are dietary records, 24-h dietary recall and food frequency questionnaires. There is continued discussion over the merits of these respective tools.

24-hour recalls

Tool:
Structured interview. Trained interviewer asks child &/or adult to recall all food and drink during previous 24-hrs (McPherson 2000) Can be administered via paper records or with a computer-assisted program. Prompts for quantification of portion size such as 2 or 3 dimensional food models are typically employed (McPherson 2000)

Validity:
Improves with age & adult assistance. Overcomes the age related bias as seen with diet records. Parents can proxy for children <8yr & can assist older children. Food record prompts can be used. Energy over/under-estimated. Energy intake overestimated in children <9, but accurate for 15-18 year old children.

When to use:
For estimating group means: A single recall is sufficient. All days of the week should be equally represented, or at least weekdays and weekend days, due to systematic difference between days of the week.
For estimating the distribution of individual intakes within a group or for obtaining usual individual intake: Multiple recalls need to be collected eg. to determine the proportion of individuals at risk of inadequate intake of a particular nutrient or to predict individual outcomes such as serum cholesterol (McPherson 2000). The number of days depends on the day-to-day variation of intake of the nutrient of interest and the level of precision desired. For energy and the macronutrients, 3-10 days has been suggested. For other nutrients, up to 50 days may be required. Four to 5 days are often selected as a reasonable compromise for assessing energy & the macronutrients. If an estimate of long-term intake is required, 3-4 days in each of the four seasons of the year is ideal (ie. 12-16 days in total). – see Nelson 1989 for more information on the number of days required.

Bias:
In adults, recalls tend to underestimate intake by about 10% compared with observed intake (Biro 2002)

Participant Burden: Low for single recall. Increased burden for increasing number of recalls.
**Strengths:**
Inexpensive, quick, lower respondent burden than for prospective methods, can assess current or past diet, can be repeated to gain measure of daily variation and improve precision. The number of days included depends on the day-to-day variation of the nutrients of interest (Gibson nut epi text).
Respondents less likely to change eating pattern (Gibson nut epi text)
(Biro 2002) No literacy requirement, applicable for broad populations of different ethnicity, does not alter food intake pattern
Advantages for use in children:
-Does not require the participant to be literate or motivated because it is quick collection method, making it more appropriate in particular for teenagers (Cade doc, under Shaffer reference)
This dietary method can be conducted successfully both face-to-face or over the phone (Cade, Shaffer, Biro 2002)
The method can be used and has shown to be suitable to assess dietary intake for a large array of participants who are of different ethnicities (Biro, 2002).
Does not alter an individuals usual intake because of short collection time
24-hr recalls are less time-consuming, less intrusive and cheaper to administer and therefore potentially more likely to be acceptable to adolescents (Livingstone & Robson 2000)

**Limitations:**
Biases caused by errors in memory, perception, conceptualization of food portion sizes, presence of observer (Nelson nut epi text). Usual intake of an individual cannot be assessed from one day’s intake due to day by day variability (Biro 2002). Dependent on regular eating habits. Food composition tables used to estimate nutrient intake. Overreporting of foods believed to be healthy.
Reliant on skilled interviewers (Biro 2002)
Expensive (Willett 1998)
Recall methods require the use or access to a nutrient analysis program in order to examine and evaluate data collected. This then poses the problem of how up to date the nutrition composition tables and how appropriate the tables are to the actual food compositions of foods available in the area where the data was collected (Willett 1998).
Repeated 24-hr recalls needed to get population distributions of habitual intake (biro 2002).
Collection of multiple days of intake is not feasible for most epidemiologic studies.
(Randall 1991)
Higher respondent burden for multiple days may result in lower cooperation and data quality.
Considerations (miscellaneous):

Recall errors associated with children have shown to be reduced if children are encouraged to reconstruct the context in which foods are eaten: events, activities, people, meal type and time (Livingstone 1992). Extensive probing has been found to substantially increase estimates of energy intake obtained by 24-hr recall in younger respondents (Willett 1998, ch 4).

For recalls, it is usually statistically most efficient to increase the number of individuals in the sample rather than to increase the number of days beyond 2 days per individual – however, for food records, it may be more cost effective to train fewer people in methods of record keeping and increase the number of days per individual. If multiple days are collected, a combination of days of the week should be randomly assigned and non-consecutive (as consecutive days may not be independent of one another).

It should also be noted that in order to effectively implement a 24 hour recall in research settings to remember to put into practice quality control procedures both in the training of individuals who will be collecting the data both before data collection begins and also during data collection ensure that all data is being collected in the same manner. For more info see article by Shaffer, 2004.

After the age of 8, it has been reported that children can just as accurately report dietary intake as their parents, but only for the previous 24 hours (Livingstone, 2004,) (Baxter, Smith, 2004). As the length of time between acquisition of data increases, the reporting accuracy decreases, thus in relation to research of dietary intake in children the sooner the food is recalled about a certain time period, the greater the accuracy of the information obtained (Baxter, 2004).

In children >10 and adolescents, it recommends for the most accurate measure of energy intake, food recall methods need to be implemented to both the child and the care taker, however information still only reliable for group level not individual (ref 50 in Foster paper).

**Food recalls** require the child to think abstractly about specific foods. Can be supplemented with direct observation and measurement of school meals the previous day. Graduated food models and structured dialogues strengthen this method (Frank 1991).

24-hr recalls can be used with acceptable validity with children as the informants if the children are 10 years or older. Below that age, parents or guardians help is necessary and in that case the accuracy is comparable to that found in adults (Biro 2002).
Validation with doubly labeled water have demonstrated the 24-hr recall to be representative of EE in children (Biro 2002)

Food records

Tool:
Written records of actual intake of foods and beverages consumed at the time of consumption for a specified period (usually 3, 5, 7 days). Food can be measured using weights or estimated using household measures (eg. cups, tablespoons), food models, pictures etc.

Validity: Underreporting of energy intake may increase with age. Possible differences between kids of different ethnic backgrounds (McPherson 2000)

When to use:
For estimating group means: A single record is sufficient. All days of the week should be equally represented, or at least weekdays and weekend days, due to systematic difference between days of the week.
For estimating the distribution of individual intakes within a group or for obtaining usual individual intake:
Multiple records need to be collected eg. to determine the proportion of individuals at risk of inadequate intake of a particular nutrient or to predict individual outcomes such as serum cholesterol (McPherson 2000). The number of days depends on the day-to-day variation of intake of the nutrient of interest and the level of precision desired. For energy and the macronutrients, 3-10 days has been suggested. For other nutrients, up to 50 days may be required. Four to 5 days are often selected as a reasonable compromise for assessing energy & the macronutrients. If an estimate of long-term intake is required, 3-4 days in each of the four seasons of the year is ideal (ie. 12-16 days in total). – see Nelson 1989 for more information on the number of days required.

Bias:
Alterations to food intake as with any prospective method.
Diet records, either weighed or estimated, have been shown to provide unbiased records of EI in lean subjects up to 9 years old. However, adolescents under-report EI by this method by approximately 20% with the greatest bias observed in older subjects (Livingstone & Robson 2000, Livingstone et al 2004).

Burden: High

Strengths: Nelson (nut epi text)
Current diet, direct observation of what is eaten, duration of survey can be varied to meet requirements for precision of estimates of food consumption or nutrient intake. Widely used, facilitates comparisons between studies, precision of portion sizes. (Biro 2002) often regarded as the ‘gold standard’ among dietary assessment methods. Does not rely on respondents’ memory. Open-ended.

**Limitations:** Nelson (nut epi text)

Labour-intensive for both the researchers and participants, requires literacy and numeracy skills, subjects need to be well motivated, usual consumption pattern may change due to – inconvenience of recording, choice of foods which are easy to record, beliefs about which foods are healthy or unhealthy. Overweight subjects tend to underreport true consumption levels. Coding and data entry errors common. Food composition tables used to estimate nutrient intake.

Expensive (Willett 1998), (Gibson nut epi text)

Unrepresentative of usual intake if only a few days assessed. (Willett 1998)

Inappropriate for assessment of past diet. (Willett 1998)

Collection of multiple days of intake is not feasible for most epidemiologic studies. (Willett 1998)

**Bias**

The validity of records or recalls for measuring long-term or usual food intake improves with more days of recording, indicating multiple records may be needed. Mutiple records/recalls can introduce compliance issues for children because of the high respondent burden (McPherson 2000).

**Considerations (miscellaneous):**

If multiple days are collected, days should be randomized to cover weekday and seasonal variation (Biro 2002). The reporting must be done at the time of consumption on paper or using a dictaphone (Biro 2002).

Higher respondent burden for multiple days may result in lower cooperation and data quality (Randall 1991).
**Food records** require children to write names of foods legibly, recognise and describe quantities, decipher food label information and retain the record in their possession for completion of all entries during the day (Frank 1991).

In most validation studies carried out in children that have employed weighed or estimated diet records, they have been shown to provide unbiased records of energy intake in LEAN subjects to age 9, however in older children food records unanimously underreport by 20% with greater bias in older children (Livingstone, 2004).

**How long do you need to get participants to keep the records for?**

Nelson and colleagues have addressed how to calculate the number of days required to estimate intakes of individuals nutrients for children aged 2-17 years.

7 day dietary diaries have been shown to give unbiased estimates of energy intake in normal weight children between 4-10 years, but an underreporting by 20% has been shown when using this method to older children and adolescents. 7 days of food records for children <4 are inadequate because time period is too short (Domel, Baxter et al 1997).

A 3 day record is long enough to gain insight into regular food intake without being to labour intensive for caregivers or invasive for toddlers, but is still sufficient to determine differences in nutrient intake between groups and comparison with RDI's (Socnes, Miller, Begley, 2001)

**FFQs**

**Tool:**

Report frequency of consumption of a defined list of foods, +/- portion size to estimate the intake of one or several specific nutrients over a period greater than 24 hours (eg. week/s, month/s, year/s)

**Validity:**

Improves with detailed food list appropriate to population, shorter referent periods (eg. Previous day, week or month) (McPherson 2000)

**Reliability:**

Higher intakes in first administration. Improved correlation with shorter referent time period
When to use:
To rank respondents by intake level & predict individual level health outcomes. May be parent-completed.

When not to use: Not for assessing exact nutrient intake

Bias:
Significantly overestimate habitual energy intake (Biro 2002). First administration of FFQ results in higher energy and nutrient intakes and greater frequencies of consumption than subsequent administrations (McPherson 2000).

Burden: Low, cheap to administer. Burden is in developing food list and validating in study population (McPherson 2000)

Strengths: Nelson (nut epi text)
Relatively inexpensive, quick, lower respondent burden than for prospective methods, can assess current or past diet, suitable for large-scale surveys, can be posted, short version can focus on specific nutrients with few food sources. FFQs are less time-consuming, less intrusive and cheaper to administer and therefore potentially more likely to be acceptable to adolescents (Livingstone & Robson 2000). Allows ranking of individuals by food or nutrient intakes so that characteristics of those with high and low intakes may be compared. Usual eating patterns are not affected (Biro 2002).

- Lower respondent burden
- Less time-consuming
- Less intrusive
- Relatively inexpensive to collect information
- Trained interviewers not needed
- Can be self-administered
- Total diet or selected foods/nutrients can be assessed
- Can be used to rank according to nutrient intake
- Procedure can be automated
- Practical for large-scale epidemiologic studies
- No interviewer required – can be self-administered, over the phone, by computer, on the web? or posted
- Suitable for large-scale studies (Biro 2002)
- Ability to focus on particular nutrients or total diet
- Relatively inexpensive
- Procedure does not alter habitual intake
- Low respondent burden
• Can rank individuals according to intake
• Can be pre-coded to aid in data entry and handling
• Can be made machine readable which saves time and expensive in administration and analysis
• Cannot accurately retrieve unique details of individuals intake
• High level of motivation required

Limitations: Nelson (nut epi text)
Biases caused by errors in memory, perception, conceptualization of food portion sizes, presence of observer. Daily variation in diet not usually assessed. Dependent on regular eating habits. Food composition tables used to estimate nutrient intake. Requires validation in relation to reference measure. Literacy and numeracy skills needed if self-completed.
Not open-ended (Biro 2002)
Does not allow quantification of individual intake (Rockett 1997 #7).
• Time involved in development and validation
• Literacy and numeracy skills of subjects
• Recalls depends on memory
• Quantification of ??? imprecise because of poor recall and use of standard portion sizes
• FFQ not open-ended (Biro 2002)

Considerations (miscellaneous)

Age/population

• Development of food lists has to be adapted to study population (Biro 2002)
• Long, detailed lists show better correlation coefficients in validation than shorter
• If intended for children they cannot complete a frequency timeframe of more than 1 week (Crawford, oobarzack 1994)
• Children less than 10 years of age cannot correctly conceptualise frequency (Livingstone 2000).
• No difference between boys and girls (McPherson).
• No difference between age groups (9-12, 13-15, 16-18 years) (McPherson 2000)

The literature on the use of FFQs in children and adolescents has been sparse, subject only to relative validity checks and yielding inconsistent results that are difficult to interpret (Livingstone & Robson 2000).
For micronutrients with high within-person variability & contributed by relatively few food sources, a FFQ specifically designed to assess the selected nutrients is likely to provide the most accurate estimates.

(Randall 1991)
Ability to estimate intake over the extended period of time, more appropriate for programs aiming to develop long-term behaviour change. These methods do not provide precise estimates of absolute nutrient intake, but classify subjects on the basis of their positions relative to others - assigned by quantile ranks.

The development of the food list is crucial to a successful and reliable data collection. It is difficult to develop a comprehensive list including enough but not too many food items so that respondents of very different eating habits can find the right answer. Ideally, the food list has to be adapted to the studied population (Biro 2002).

To comprehend the FFQ children usually have to be older than 12 years (Biro 2002).

(Randall 1991)

**Adapting FFQs for children:**

Five issues -

**Food list:** Children are more likely to interpret questions literally, impairing their ability to report accurately about composite foods..

**Time intervals:**
Concept of the past can make estimating frequency of food use during a specific time period more problematic. Time periods may need to be fixed by meaningful start and end points. Time periods may need to be shorter as children typically have more changeable food patterns.

**Response set:**
Children tend to respond affirmatively to authoritatively phrased questions, or if unsure of the question, do not have an opinion or are disinterested, thereby reducing accuracy of information provided.

**Context of questioning:**
Words that are consistent with a child's understanding of a given situation need to be used. Probes may need to be more specific.

**Structuring the questionnaire:**
Easier questions on topics of interest asked first, followed by more difficult or more threatening questions.

(Subar, Thompson et al. 2001)
The most practical and economical method for collection of comprehensive dietary data in large epidemiologic studies is the food frequency questionnaire (FFQ). Compared with other approaches, such as 24-hour recalls and food records, the FFQ generally collects less detail regarding the foods consumed, cooking methods and portion size. Therefore, the quantification of intake is not considered as accurate. However, unlike records or recalls, FFQs are designed to capture usual dietary intake. Most are completed independently by a respondent and are relatively inexpensive. Therefore, the FFQ is usually the method of choice in large-scale epidemiologic studies.

**Diet history**

The original diet history usually starts with an interview to determine the usual meal pattern, most frequently from a 24h recall. The second step is a food frequency questionnaire and the third one a 3 day dietary record. Thus, it is a combined method and the strengths and weaknesses of each method will be partly equalized (Biro 2002).

Diet history is usually more qualitative than quantitative, allowing detailed information about food preparation, eating habits (McPherson 2000)

**Observation**

Useful for assessing children who are preliterate and in a lunchroom or school group setting. Intensively trained observers unobtrusively watch the children to ascertain foods, brand names and portions consumed. (McPherson 2000).

**Strengths**

**Limitations**

Skilled staff required, labour and time intensive, high respondent burden (Biro 2002).

**Bias**
Limited assessment, but EI seems biased towards overestimation (by 8%), with greater overestimation in children under 9 years. This method lacks precision at the individual level, with 35% of results by diet history outside the 95% CI that assume a valid measure of habitual intake (Livingstone & Robson 2000).
**Summary Points**

- There are too few validation studies in children to justify advocating one particular method over another.

- The current body of literature recommends validation studies of all dietary assessment methods.

- Parent/carer assistance required for children <8 years.

- Self-report reasonably accurate from 9 years.

- Children and adolescents, particularly girls, have approximately twice the variance of intake than observed for adults.

- Adolescent self-reports are usually biased in the direction of under-reporting – with energy under-reporting increasing with age during adolescence (due to novelty for younger children, disinterest in adolescence).

- As with adults, overweight and obese children and adolescents underreport significantly more than their non-obese counterparts, with the extent of misreporting increasing with age (up to 40% EI in obese adolescents).

- Some evidence that children with central fat distribution have higher rates of underreporting of energy intake than lean or obese children or those with peripheral fat distribution.

- Those who under-report on one occasion are likely to under-report on a second occasion, in which case the bias cannot be eliminated by repeated measures.

- There is a bias towards underestimation in obese 6-7 year old children who have at least one obese parent.
Key References


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| 24-hour recall | - Short administration time  
- Defined recall time  
- Does not require literacy or numeracy skills  
- Procedure does not alter habitual dietary habits  
- Low respondent burden  
- Can be telephone administered  
- Procedure can be automated | - Recall depends on memory  
- Portion size difficult to estimate  
- Skilled interviewers required  
- Expensive to collect and code  
- Reliable and accurate nutrient analysis program required  
- Higher respondent burden for multiple days  
- Not feasible for most epidemiologic studies | - Portion size tends to be overestimated by children, and greater extent in those that eat smaller portions  
- Underestimation is more frequent in individuals who eat smaller portions  
- Quantification tools do not necessarily improve the accuracy of portion size estimation  
- Food record prompts can be used  
- In adults, recalls tend to underestimate intake by 10% of observed intake  
- Recall errors can be reduced by reconstructing the context in which foods are eaten (events, activities, people etc) and by substantial probing |
| Food record | - Record does not rely on memory  
- Defined record time  
- Intake can be quantified  
- Training can be group administered  
- Procedure can be automated | - Recorder must be literate  
- High respondent burden  
- Food eaten away from home less accurately recalled  
- Procedure may alter habitual dietary habits  
- Validity may decrease as recording days increase (Berg 1998 #280)  
- Expensive to collect and code  
- Reliable and accurate nutrient analysis program required  
- Higher respondent burden for multiple days  
- Not feasible for most epidemiologic studies | - Adolescents underreport EI by approximately 20% (with underreporting with increased age)  
- Reasonably accurate EI for children 4-10 years |
<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Special Considerations for Obesity Research</th>
</tr>
</thead>
</table>
| FFQ    | - Trained interviewers not needed  
        - Interviewer or self-administered on paper, computer, web (Livingstone et al. 2004)  
        - Relatively inexpensive to collect  
        - Procedure does not alter habitual dietary habits  
        - Low respondent burden  
        - Total diet or selected foods or nutrients can be assessed  
        - Can be used to rank according to nutrient intake  
        - Procedure can be automated  
        - Practical for large-scale epidemiologic studies | - Recall depends on memory  
        - Literacy and numeracy skills required  
        - Period of recall imprecise  
        - Quantification of intake imprecise because of poor recall or use of standard portion sizes  
        - Specific food descriptions not obtained  
        - Time involved in development and validation | - Development of food lists has to be adapted to study population  
        - More comprehensive lists show greater validity  
        - Overestimate EI  
        - Validity improves with detailed food list appropriate to period and shorter reference period.  
        - Higher intakes recorded in first administration  
        - Due to recall difficulties, it is uncertain whether children provide valid responses when recalling periods greater than 1 day  
        - However, time periods fixed by meaningful start and end may increase validity |
## Dietary Intake Studies (Children): Australia

<table>
<thead>
<tr>
<th>Ref</th>
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<th>Study Pop</th>
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</thead>
<tbody>
<tr>
<td>NNS</td>
<td>1995</td>
<td>Assess dietary intake of rep sample of Australian adults &amp; children</td>
<td>N=1804 12-18 years completed FFQ + 24 hr recall</td>
<td>24-hr recall &amp; FFQ (&gt;12 yrs)</td>
<td>Cross-sectional</td>
<td></td>
<td>Australia</td>
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<tr>
<td>(Magarey and Boulton 1987)</td>
<td>1987</td>
<td>Energy and nutrient intake at age 6 and its relationship to body size and fatness</td>
<td>N=154 healthy 6 year olds (91 boys, 63 girls)</td>
<td>3d WFR</td>
<td>Longitudinal study from birth.</td>
<td>Stature was positively correlated with energy and fat intake</td>
<td>Australia</td>
</tr>
<tr>
<td>(Magarey, Nichols et al. 1987)</td>
<td>1987</td>
<td>Energy, macro &amp; micronutrient intake of 8 year olds</td>
<td>N=141 healthy 8 year olds (78 boys, 63 girls)</td>
<td>4d WFR</td>
<td>Longitudinal study from birth</td>
<td></td>
<td>Australia</td>
</tr>
<tr>
<td>(Jenner, Neylon et al. 1989)</td>
<td>1989</td>
<td>To compare FFQ completed by children, FFQ completed by parents via post, 1-3 24 hr recalls completed by children. FFQ 175-item, 'past week', no portion sizes used</td>
<td>225 children, Year 7 classes in state primary schools in Perth (ages 11-12)</td>
<td>FFQs and 24 hr recalls</td>
<td></td>
<td>Poor agreement between 24hr &amp; FFQ. FFQ nutrient means much higher for all nutrients. Nutrient intakes for FFQ consistently higher than for 24hr recall. *why not adjust for energy?</td>
<td>Australia</td>
</tr>
<tr>
<td>(Sempos, Briefel et al. 1992)</td>
<td>1992</td>
<td>Dietary survey methods for NHANES III</td>
<td>24hr recalls + targeted FFQ (for water, alcohol, specific foods &amp; food gps, milk - for calcium, vitamins A and C over past month)</td>
<td></td>
<td></td>
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<tr>
<td>(Burke, Beilin et al. 2001)</td>
<td>2001</td>
<td>To investigate associations between BMI and family characteristics, including lifestyle, in parents and offspring from families</td>
<td>219 families surveyed 4 times when child was 9, 12, 15 and 18 years</td>
<td>2d FR &amp; FFQs</td>
<td>Longitudinal survey undertaken 3 yearly between 9 and 18 years</td>
<td>Australia</td>
<td></td>
</tr>
<tr>
<td>(Wang, Patterson et al. 2003)</td>
<td>2003</td>
<td>Relationship of BMI to energy and fat intake</td>
<td>N=1581 boys and girls aged 7-15</td>
<td>24hr recalls</td>
<td>No significant differences in the average energy intake of energy &amp; fat in overweight or non-overweight children &amp; adolescents.</td>
<td>Australia</td>
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</table>

WDR = weighed food record  
FR = food record
### Dietary Intake Studies (Children): O/S

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<tr>
<td>(Zoumas-Morse, Rock et al. 2001)</td>
<td>2001</td>
<td>Children's intake of energy and macronutrients - hypothesis that macronutrient composition of meals would vary based on consumption location (ie. Home vs restaurant)</td>
<td>7-11 yrs (n=367) - completed 1x24hr recall each with parent; 12-17 yrs (n=435), self-completed 1x24hr recall each.</td>
<td>24-hr recall using 'Nutrition Data System' software + measuring cups etc &amp; photographs. Location of meal recorded.</td>
<td>Cross-sectional</td>
<td>Energy &amp; macronutrient intake not statistically significant between gender or age (as found in other studies). Mean estimates for %E from fat &amp; SFA were higher than current recs. Restaurant meals accounted for 6% of all eating but E content of these meals was 55% higher than home meals, esp fat &amp; SFA.</td>
<td>Canada</td>
</tr>
<tr>
<td>(Johnson-Down, O'Loughlin et al. 1997)</td>
<td>1997</td>
<td>Diet and physical activity assessment</td>
<td>498 children aged 9-12</td>
<td>24hr recalls with graduated food models</td>
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<td>(Sempos, Briefel et al. 1992)</td>
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<td>24hr recalls + targeted FFQ (for water, alcohol, specific foods &amp; food gps, milk - for calcium, vitamins A and C over past month)</td>
<td>Cross-sectional</td>
<td>50% of students consumed too much fat and two-thirds consumed too much sugar as compared to recs. It seemed that a healthy lifestyle was associated with a healthy diet. Meal patterns - ie. Skipping were also included as supplementary questions.</td>
<td>US</td>
<td></td>
</tr>
<tr>
<td>(Anderson, Nes et al. 1995)</td>
<td>1995</td>
<td>To describe &amp; evaluate dietary habits and relate that to other lifestyle factors.</td>
<td>1564 students (18 yrs)</td>
<td>Validated FFQ (see ref 244)</td>
<td>Cross-sectional</td>
<td></td>
<td>Norway</td>
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<td>(Neumark-Sztainer, Hannan et al. 2003)</td>
<td>2003</td>
<td>To examine family meal patterns and dietary intake in adolescents</td>
<td>N=4,746, 11-18 years</td>
<td>YAQ + EAT (eating among teens) survey, self-completed @ school</td>
<td>Cross-sectional</td>
<td>Family meals appear to promote positive dietary intakes among adolescents</td>
<td>US</td>
</tr>
</tbody>
</table>

**Limitations in our study:**

**GENERAL NUT EPI**

**Nelson – Nut Epi text:**

Biases in assessing individual dietary intakes;
- Simplified dietary intake to make the recording process easier
- Limitations of food composition tables
- Coding and data entry errors
- Altered reporting due to the perceived health or lack of healthiness of a food
References


From DAA presentation:


